

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: Anisul Khan et al.

SERIAL NO.: Not yet assigned

FILED: December 18, 2000

FOR: APPARATUS FOR PERFORMING
SELF CLEANING METHOD OF FORMING
DEEP TRENCHES IN SILICON SUBSTRATES

§ GROUP ART UNIT: Unknown

§

§ EXAMINER: Unknown

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§ Attorney Docket No.:
AM-3396.D1

§

§

Date: December 18, 2000

PRELIMINARY AMENDMENT "A"

Hon. Commissioner for Patents
Washington, DC 20231

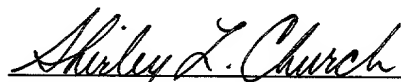
Sir:

This Preliminary Amendment "A" accompanies a divisional application of U.S. Application
Serial No. 09/405,349, filed September 24, 1999.

CERTIFICATE OF MAILING UNDER 37 CFR 1.10

I hereby certify that this paper is being deposited with the U.S. Postal Service on the date shown below
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Date: December 18, 2000


Shirley L. Church, Reg. No. 31,858

Please amend the application as follows:

IN THE DRAWINGS:

Please replace the originally filed informal drawings with the enclosed formal drawings. The formal drawings have been amended to correct for formal errors. Marked drawings showing the changes in red have been submitted for review by the Examiner.

IN THE TITLE:

Before "SELF", please insert -- APPARATUS FOR PERFORMING --.

IN THE SPECIFICATION:

All page numbers referred to below are the numbers shown at the bottom of the page of the application specification, as originally filed.

Page 3, line 30, please delete "process. Reactive" and insert -- process, reactive --

Page 4, line 20, please delete "processing" and insert -- performing --.

Page 4, line 28, after "a mixture of", please delete "processes" and insert -- process --.

Page 5, line 2, after "102", please insert -- to --.

Page 5, line 2, after "1.5 μm ", please insert a comma -- , --.

Page 5, line 4, after "6.5 μm ", please insert a comma -- , --.

Page 5, line 10, after "including", please insert -- a --.

Page 5, line 16, after "trench.", please delete "The" and insert -- A --.

Page 5, line 28, after "introduction of", please insert -- a --.

Page 6, line 2, please delete "accumulations" and insert -- residue accumulation --.

Page 6, line 8, please delete “accumulations” and insert -- residue accumulation --.

Page 6, line 10, please delete “shortcoming” and insert -- shortcomings --.

Page 6, line 31, after “having”, please insert -- a --.

Page 6, line 32, please delete “pattern” and insert -- patterning --.

Page 7, line 24, after “having”, please insert -- a --.

Page 7, line 25, please delete “pattern” and insert -- patterning --.

Page 7, line 35, after “processing”, please insert -- of --.

Page 8, line 16, after “plurality”, please delete “the” and insert -- of --.

Page 8, line 24, please delete “risk” and insert -- risking --.

Page 8, line 29, please delete “less” and insert -- larger --.

Page 9, line 4, after “layer”, please delete “removes” and insert -- allows the omission of --.

Page 9, line 5, please delete “construced” and insert -- constructed --.

Page 9, line 7, after “application”, please insert -- Serial No. 09/102,527, --.

Page 9, line 19, please delete “self-clean” and insert -- self-cleaning --.

Page 9, line 23, please delete “favorably” and insert -- favorable --.

Page 9, line 30, after “skill”, please insert -- in the art --.

Page 10, line 5, after “embodiment of”, please insert -- the --.

Page 10, line 28, after “including”, please insert -- a --.

Page 11, line 4, after “1 : 10,”, please delete “with” and insert -- while --.

Page 11, line 20, after “etching”, please insert -- of --.

Page 12, line 10, please delete “conduct”.

Page 12, line 12, after “substrate”, please insert -- is conducted --.

Page 12, line 15, please delete “removes” and insert -- allows the omission of --.

Page 13, line 3, after “comprising”, please insert -- an --.

Page 13, line 10, after “chamber”, please insert -- are --.

Page 13, line 21, after "10", please delete "mT" and insert -- mTorr --.

Page 13, line 21, please delete "8T" and insert -- 8 Torr --.

Page 13, line 22, after "1200 W,", please insert -- and --.

Page 13, line 27, after "removes", please insert -- the --.

Page 14, line 8, please delete "conduct".

Page 14, line 10, after "chamber", please insert -- is conducted --.

Page 14, line 10, after "processing", please insert -- of --.

Page 14, line 28, after "maintained at", please insert -- a chamber pressure of --.

Page 14, line 28, after "30", please delete "mT" and insert -- mTorr --.

Page 14, line 29, please delete "8T" and insert -- 8 Torr --.

Page 15, line 1, please delete "sec" and insert -- seconds --.

Page 15, line 7, after "second", please insert -- part --.

Page 15, line 16, after "30", please delete "mT" and insert -- mTorr --.

Page 15, line 16, after "8", please delete "T" and insert -- Torr --.

Page 15, line 22, please delete "12T and 16T" and insert -- 12 Torr and 16 Torr --.

Page 15, line 27, please delete "6mT" and insert -- 6 mTorr --.

Page 15, line 27, please delete "16T" and insert -- 16 Torr --.

Page 15, line 28, please delete "last" and insert -- lasts --.

Page 16, line 10, after "1 : 10,", please delete "with" and insert -- while --.

Page 16, line 27, after "etching", please insert -- of --.

Page 16, line 29, after "obtained by", please insert -- using --.

Page 16, line 29, after "including", please insert -- a --.

Page 17, line 3, after "22", please delete "mT" and insert -- mTorr --.

Page 17, line 4, please delete "16T" and insert -- 16 Torr --.

Page 17, line 6, after "trench", please insert -- etch --.

Page 17, line 7, after "profile", please insert -- control --.

Page 17, line 19, after "chamber,", please delete "remove".

Page 17, line 19, after "substrate", please insert -- is removed --.

Page 17, line 27, after "Yes", please delete "process".

Page 17, line 27, after "wafer", please insert -- is processed --.

Page 18, line 1, after "the exposed layer is", please delete "a process".

Page 18, line 22, after "continues", please delete "with".

Page 19, line 3, after "the substrate to", please insert -- the --.

Page 20, line 2, after "between those", please delete "chamber" and insert -- chambers --.

Page 20, line 3, after "skill", please insert -- in the art --.

Page 20, line 10, after "skill", please insert -- in the art --.

Page 20, line 16, after "skill", please insert -- in the art --.

Page 20, line 22, after "trench", please insert -- etch --.

Page 21, line 3, after "810,", please delete "conduct".

Page 21, line 3, after "etch", please insert -- is conducted --.

Page 21, line 4, after "on the substrate", please delete "are" and insert -- is --.

Page 21, line 15, after "skill", please insert -- in the art --.

Page 21, line 21, please delete "abou1" and insert -- about --.

Page 21, line 25, after "such that", please delete "as".

Page 21, line 28, before "from", please insert -- is removed --.

Page 22, line 20, after "According to this step,", please delete "load".

Page 22, line 21, after "layer", please insert -- is loaded --.

Page 23, line 4, after "step 835,", please delete "conduct".

Page 23, line 4, after "process", please insert -- is conducted --.

Page 23, line 10, after “therefore,”, please delete “removes the clean” and insert -- allows the omission of the cleaning step --.

Page 23, line 21, after “sources for”, please insert -- a --.

Page 23, line 27, after “comprising”, please insert -- an --.

Page 24, line 13, after “10”, please delete “mT” and insert -- mTorr --.

Page 24, line 13, please delete “8T” and insert -- 8 Torr --.

Page 24, line 14, after “1200 W,”, please insert -- and --.

Page 24, line 18, after “removes”, please insert -- the --.

Page 24, line 24, after “skill”, please insert -- in the art --.

Page 24, line 27, after “In this step,”, please delete “conduct”.

Page 24, line 29, after “chamber”, please insert -- is conducted --.

Page 24, line 29, after “processing”, please insert -- of --.

Page 25, line 11, after “combination of”, please insert -- a --.

Page 25, line 27, after “maintained at”, please insert -- a pressure of --.

Page 25, line 27, after “30, please delete “mT” and insert -- mTorr --.

Page 25, line 28, please delete “8T” and insert -- 8 Torr --.

Page 25, line 20, please delete “sec” and insert -- seconds --.

Page 25, line 26, after “second”, please insert -- part --.

Page 26, line 2, after “30”, please delete “mT” and insert -- mTorr --.

Page 26, line 2, after “8”, please delete “T” and insert -- Torr --.

Page 26, line 8, please delete “12T and 16T” and insert -- 12 Torr and 16 Torr --.

Page 26, line 10, after “trench”, please insert -- etch --.

Page 26, line 13, please delete “6mT” and insert -- 6 mTorr --.

Page 26, line 13, please delete “16T” and insert -- 16 Torr --.

Page 26, line 14, please delete “last” and insert -- lasts --.

Page 26, line 17, after "Application", please insert -- Serial No. 09/102,527, --.

Page 26, line 21, after "including", please insert -- a --.

Page 26, line 26, after "1 : 10," please delete "with" and insert -- while --.

Page 27, line 15, after "including", please insert -- a --.

Page 27, line 19, after "22", please delete "mT" and insert -- mTorr --.

Page 27, line 20, please delete "16T" and insert -- 16 Torr --.

Page 27, line 23, after "profile", please insert -- control --.

Page 28, line 5, after "chamber," please delete "remove".

Page 28, line 5, after "substrate", please insert -- is removed --.

Page 28, line 11, please delete "wafer".

Page 28, line 12, after "residues," please delete "remove".

Page 28, line 13, after "substrate", please insert -- is removed --.

Page 28, line 15, please delete "loadlocks" and insert -- loadlock --.

Page 28, line 20, after "Yes", please delete "process".

Page 28, line 20, after "wafer", please insert -- is processed --.

Page 28, line 24, after "layer is", please delete "a process".

Page 28, line 28, please delete "remain" and insert -- remains --.

Page 29, line 13, please delete "processes" and insert -- processed --.

Page 29, line 14, after "continues", please delete "with".

Page 29, line 17, after "according", please delete "with" and insert -- to --.

Page 29, line 19, after "chamber", please insert -- in --.

Page 29, line 19, please delete "conducts".

Page 29, line 19, after "plasma etch process", please insert -- is conducted --.

Page 30, line 10, please delete "Yee" and insert -- Ye --.

Page 30, line 10, please delete "the Proceeding of".

Page 30, line 21, after "Application", please insert -- Serial No. --.

Page 30, line 29, before "conductive", please insert -- a --.

Page 30, line 29, please delete "serve" and insert -- serves --.

Page 31, line 8, please delete "222" and insert -- 228 --.

Page 31, line 11, please delete "230" and insert -- 236 --.

Page 31, line 13, please delete "230" and insert -- 236 --.

Page 32, line 7, please delete "230" and insert -- 236 --.

Page 32, line 30, please delete "222" and insert -- 228 --.

Page 34, line 7, please delete "222" and insert -- 228 --.

Page 34, line 16, please delete "KhZ" and insert -- kHz --.

Page 35, line 12, please delete "222" and insert -- 228 --.

Page 35, line 21, please delete "222" and insert -- 228 --.

Page 36, line 3, please delete "222" and insert -- 228 --.

Page 36, line 9, please delete "independent" and insert -- independently --.

Page 36, line 11, after "Processing", please insert -- chambers --.

Page 36, line 23, after "auxiliary", please delete "409 chambers" and insert -- chamber 409 --.

Page 36, line 21, please delete "222" and insert -- 228 --.

Page 36, line 22, after "410", please insert a comma -- , --.

Page 36, line 22, after "auxiliary", please insert -- chamber --.

Page 37, line 3, after "control of system", please delete "controlled" and insert -- controller --.

Page 38, line 2, after "directs all", please insert -- of --.

Page 38, line 7, please delete "communicated" and insert -- communicates --.

Page 38, line 17, after "processing", please insert -- chambers --.

Page 38, line 18, before "409", please delete "chambers" and insert -- chamber --.

Page 38, line 27, please delete "repeats" and insert -- repeated --.

Page 38, line 3, please delete "FIGURE. 5" and insert -- Figure 5 --.

Page 39, line 7, after "520", please delete "upon" and insert -- into --.

Page 40, line 6, after "in addition to", please insert -- a --.

Page 40, line 20, please delete "222" and insert -- 228 --.

Page 40, line 29, please delete "222" and insert -- 228 --.

Page 41, line 7, after "editor, and", please delete "are" and insert -- is --.

Page 41, line 24, after "system components", please delete "of".

Page 41, line 29, after "Process", please delete "task" and insert -- tasks --.

Page 42, line 2, after "sensor registers", please insert -- a --.

Page 42, line 5, after "processes,", please delete "and" and insert -- which --.

Page 42, line 9, after "specific process", please delete "relate" and insert -- related --.

Page 42, line 9, after "to", please insert -- a --.

Page 42, line 13, after "565,", please delete "and".

Page 42, line 14, after "566", please insert -- and chamber sensor monitoring and control task
568 --.

Page 42, line 14, after "The", please delete "below".

Page 42, line 14, after "recipes", please insert -- set forth below --.

Page 42, line 21, after "throughput,", please insert -- and --.

Page 42, line 22, after "utilization and", please insert -- to --.

Page 43, line 22, after "a chamber", please delete "managers" and insert -- manager --.

Page 43, line 22, after "mainframe", please delete "manger" and insert -- manager --.

Page 43, line 22, after "580 which", please delete "control" and insert -- controls --.

Page 44, line 1, after "566", please delete "and" and insert a comma -- , --.

Page 44, line 1, after "567", please insert -- and chamber sensor monitoring and control task
568 --.

Page 44, line 6, after “similarly to”, please delete “how” and insert -- the manner in which --.

Page 44, line 15, after “576”, please delete “and” and insert a comma -- , --.

Page 44, line 15, after “577”, please insert -- and chamber sensor monitoring and control task
578 --.

Page 45, line 14, after “after which”, please insert -- the --.

Page 45, line 21, please delete “222” and insert -- 228 --.

Page 45, line 23, please delete “222” and insert -- 228 --.

Page 46, line 18, after “chambers”, please delete “were” and insert -- in which --.

Page 47, line 10, please delete “compare” and insert -- comparing --.

Page 47, line 10, please delete “obtain” and insert -- obtaining --.

Page 47, line 12, please delete “adjust” and insert -- adjusting --.

Page 48, line 11, after “As with”, please insert -- the --.

Page 48, line 11, after “task”, please insert -- 567 described --.

Page 48, line 14, please delete “comprises” and insert -- includes --.

Page 48, line 22, please delete “230” and insert -- 236 --.

Page 48, line 27, please delete “task” and insert -- tasks --.

Page 49, line 4, please delete “576” and insert -- 578 --.

Page 49, line 6, please delete “manger” and insert -- manager --.

Page 49, line 10, after “Auxiliary control manager”, please insert -- 580 --.

Page 49, line 23, please delete “task” and insert -- tasks --.

Page 49, line 27, please delete “task” and insert -- tasks --.

Page 49, line 30, after “well known”, please delete “of” and insert -- or --.

Page 50, line 4, please delete “mangers” and insert -- managers --.

Page 50, line 4, please delete “task” and insert -- tasks --.

Page 50, line 25, please delete “simultaneously,.” and insert -- simultaneously: --.

Page 51, line 12, after "skill", please insert -- in the art --.

IN THE ABSTRACT:

Page 59, line 5, please delete "residue" and insert -- residues --.

IN THE CLAIMS:

Please cancel Claims 1 - 36 without prejudice. Please amend Claim 37 and add new Claims 38 - 55, as follows.

37. (Once Amended) An apparatus for processing a semiconductor wafer in a processing chamber, said [chamber having deposits formed therein,] apparatus comprising:

a gas panel coupled to said processing chamber;

an antenna proximate to said processing chamber;

a power supply coupled to said antenna; and

a controller, coupled to said antenna and said gas panel, said controller containing a computer readable storage medium having program code embodied therein, said program code for controlling the apparatus in accordance with the following:

(a) loading a substrate into [the] a processing chamber [a substrate having a material deposited thereon] having deposits on chamber surfaces which were generated during processing of a previous substrate;

(b) [flowing from the gas panel to the processing chamber a first gaseous composition;]
conducting an etch process on said loaded substrate which simultaneously removes at least a portion of said deposits from said chamber surfaces during said etch, wherein a plasma source gas used to generate an etchant plasma is furnished to said processing chamber via said gas panel, and wherein

said power supplied to generate and maintain said plasma is furnished to said processing chamber by said power supply coupled to said antenna; and

(c) controlling said power supply to provide energy to said antenna proximate to said processing chamber, thereby effecting the removal of said deposits from said chamber surfaces [thereby providing energy to said chamber to forma first plasma from said first gaseous composition introduced into said chamber so that said first plasma removes said layer formed on said substrate and said deposits;

(d) flowing from the gas panel to the processing chamber a second gaseous composition; and

(e) controlling said power supply to provide energy to said antenna thereby providing energy to said chamber to form a second plasma from said second gaseous composition introduced into said chamber so that said second plasma removes a portion of said substrate and forms deposits in said processing chamber].

38. (New) The apparatus of Claim 37, wherein said etch process is a plasma etch process.

39. (New) The apparatus of Claim 38, wherein said etch process comprises plasma etching a layer of silicon nitride formed on said substrate.

40. (New) The apparatus of Claim 39, wherein said plasma source gas comprises a fluorine-containing compound and a bromine-containing compound.

41. (New) The apparatus of Claim 40, wherein said fluorine-containing compound is SF₆.

42. (New) The apparatus of Claim 40, wherein said bromine-containing compound is HBr.

43. (New) The apparatus of Claim 37, wherein said previous substrate comprises silicon, and wherein said processing of said previous substrate comprises plasma etching said silicon substrate, whereby a portion of said silicon substrate is removed.

44. (New) The apparatus of Claim 43, wherein plasma etching of said silicon substrate is performed using a plasma source gas comprising a halogen-containing compound and oxygen.

45. (New) The apparatus of Claim 44, wherein said halogen-containing compound is HBr.

46. (New) The apparatus of Claim 43, wherein said processing of said previous substrate comprises plasma etching an upper portion of a trench in said silicon substrate using a plasma source gas comprising a fluorine-containing compound and oxygen.

47. (New) The apparatus of Claim 43, wherein etching of said silicon substrate is performed using a plasma source gas which includes at least three reactive gases which include at least one fluorine-containing compound which does not contain silicon, at least one silicon-containing compound, and oxygen.

48. (New) The apparatus of Claim 47, wherein a volumetric ratio of said at least one fluorine-containing compound which does not contain silicon to said at least one silicon-containing compound ranges from about 100:1 to about 1:10.

49. (New) The apparatus of Claim 46, wherein said processing of said previous substrate further comprises plasma etching a lower portion of said trench in said silicon substrate using a plasma source gas which includes at least three reactive gases which include at least one fluorine-containing compound which does not contain silicon, at least one silicon-containing compound, and oxygen.

50. (New) The apparatus of Claim 47, wherein said silicon-containing compound is selected from the group consisting of SiF_4 , Si_2F_6 , SiHF_3 , SiH_2F_2 , SiH_3F , Si_2OF_6 , SiCl_2F_2 , SiClF_3 , and combinations thereof.

51. (New) The apparatus of Claim 49, wherein said silicon-containing compound is selected from the group consisting of SiF_4 , Si_2F_6 , SiHF_3 , SiH_2F_2 , SiH_3F , Si_2OF_6 , SiCl_2F_2 , SiClF_3 , and combinations thereof.

52. (New) The apparatus of Claim 47, wherein said silicon-containing compound does not contain fluorine and is selected from the group consisting of SiBr_4 , SiHBr_3 , SiH_2Br_2 , SiH_3Br , SiCl_4 , SiHCl_3 , SiH_2Cl_2 , SiH_3Cl , Si_2Cl_6 , SiH_4 , Si_2H_6 , Si_3H_8 , Si_4H_{10} , SiH_2I_2 , SiH_2I , $\text{C}_4\text{H}_{12}\text{Si}$, $\text{Si}(\text{C}_2\text{H}_3\text{O}_2)_4$, and combinations thereof.

53. (New) The apparatus of Claim 49, wherein said silicon-containing compound does not contain fluorine and is selected from the group consisting of SiBr_4 , SiHBr_3 , SiH_2Br_2 , SiH_3Br , SiCl_4 , SiHCl_3 , SiH_2Cl_2 , SiH_3Cl , Si_2Cl_6 , SiH_4 , Si_2H_6 , Si_3H_8 , Si_4H_{10} , SiH_2I_2 , SiH_2I , $\text{C}_4\text{H}_{12}\text{Si}$, $\text{Si}(\text{C}_2\text{H}_3\text{O}_2)_4$, and combinations thereof.

54. (New) The apparatus of Claim 47, wherein said fluorine-containing compound which does not contain silicon is selected from the group consisting of F_2O , F_2O_2 , NF_3 , NOF , NO_2F , SF_6 , SF_4 , S_2F_2 , S_2F_{10} , CF_4 , CH_2F_2 , CHF_3 , CH_3F , and combinations thereof.

55. (New) The apparatus of Claim 49, wherein said fluorine-containing compound which does not contain silicon is selected from the group consisting of F_2O , F_2O_2 , NF_3 , NOF , NO_2F , SF_6 , SF_4 , S_2F_2 , S_2F_{10} , CF_4 , CH_2F_2 , CHF_3 , CH_3F , and combinations thereof.

REMARKS

Applicants are submitting two sheets of drawings, with the proposed changes marked in red. In particular, Figures 2 and 3 have been amended to designate the gas panel as reference numeral 228. Reference numeral 222 had previously been used to designate both the RF bias power source (in Figure 2) and the gas panel (in Figures 2 and 3). Figure 2 has also been amended to designate the plasma as reference numeral 236. Reference numeral 230 had previously been used to designate both the reactor sidewall and the plasma in Figure 2. In addition, due to space constraints, Figure 2 and Figure 3 have been divided into Figures 2A and 2B, and Figures 3A and 3B, respectively. The marked-up drawings enclosed herewith include the changes specifically described above. Also enclosed are 11 sheets of proposed formal drawings to replace the originally filed informal drawings.

The title has been amended to reflect the presently claimed invention.

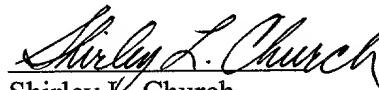
Numerous amendments have been made to the specification for the purpose of correcting typographical/grammatical errors and/or clarifying language.

Claims 1 - 35, which have been allowed in the parent application, U.S. Serial No. 09/405,349, are cancelled without prejudice. Claim 36 has also been cancelled without prejudice, to be prosecuted in a subsequently filed divisional application.

Claim 37 has been amended, as set forth above, for the purpose of clarifying the claim language. New Claims 38 - 55 have been added, as set forth above, in order to fully claim applicants' invention. Amended Claim 37 and new Claims 38 - 55 are fully supported by the originally filed specification, claim set, and drawings, and no new matter has been added to the subject application. In particular, Claims 38 - 55 merely incorporate features allowed in the method claims into apparatus control provisions.

Applicants believe that the claims as amended are in condition for allowance, and the Examiner is respectfully requested to enter the requested amendments and to pass the application to allowance. The Examiner is invited to contact applicants' attorney with any questions or suggestions, at the telephone number provided below.

Respectfully Submitted,


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Santa Clara, CA 95052

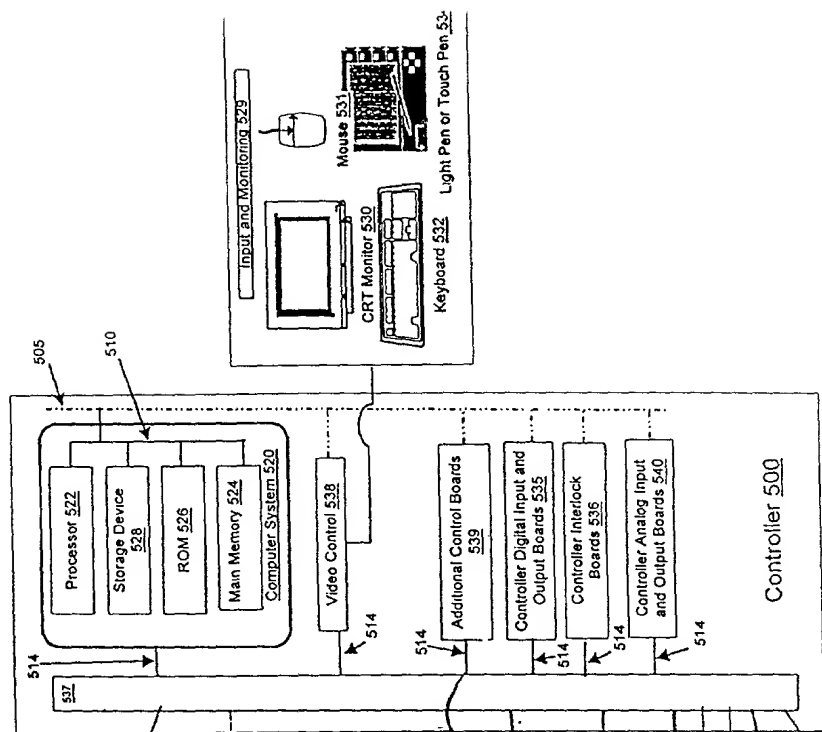
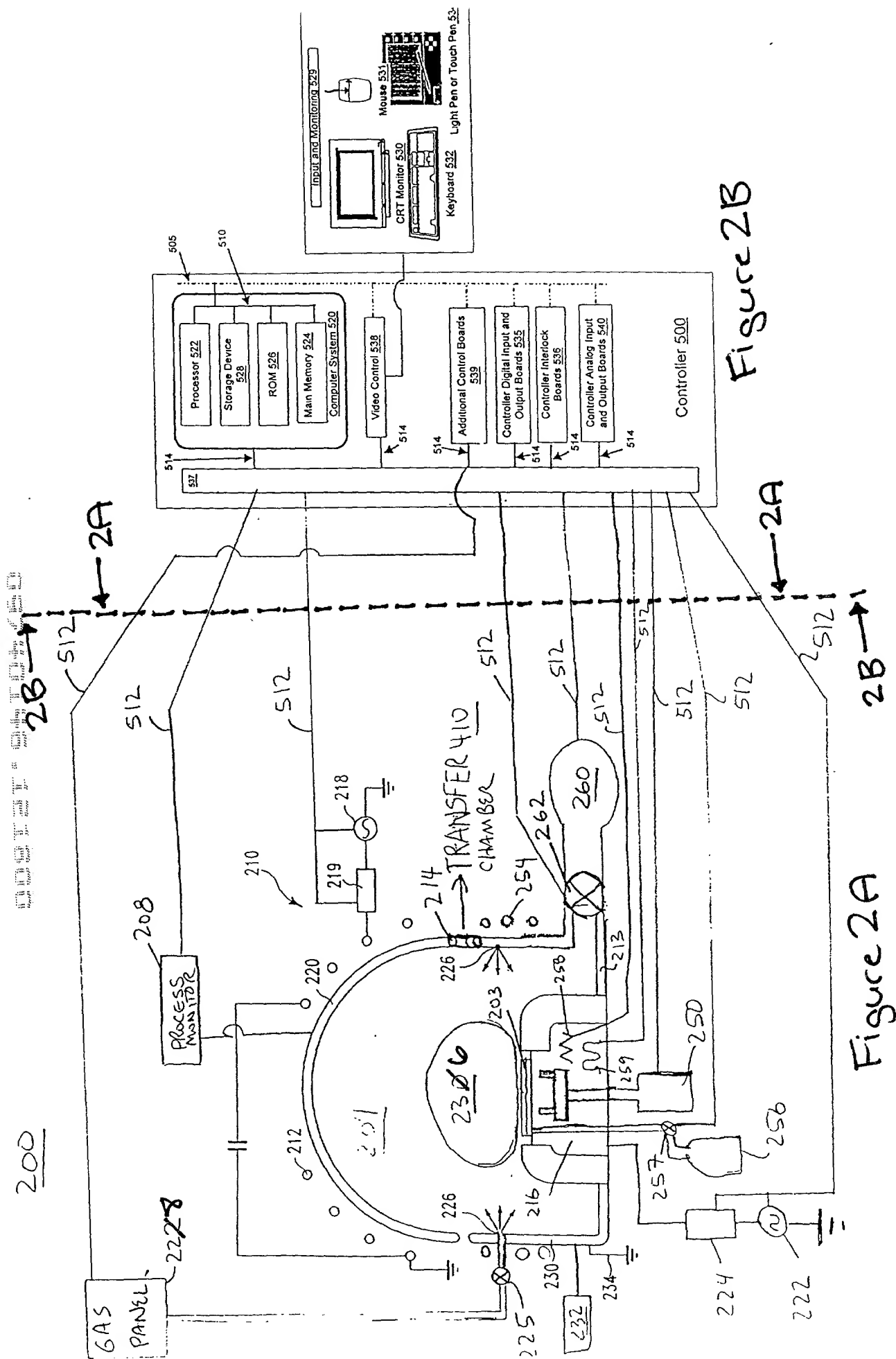


Figure 2B

Figure 2A

Figure 2

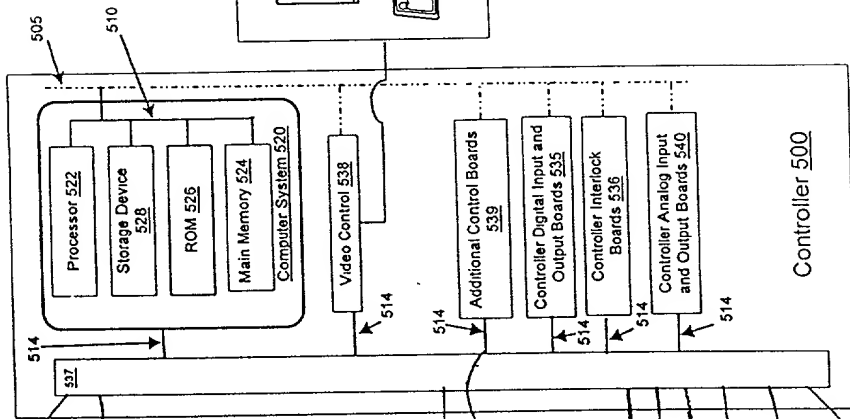
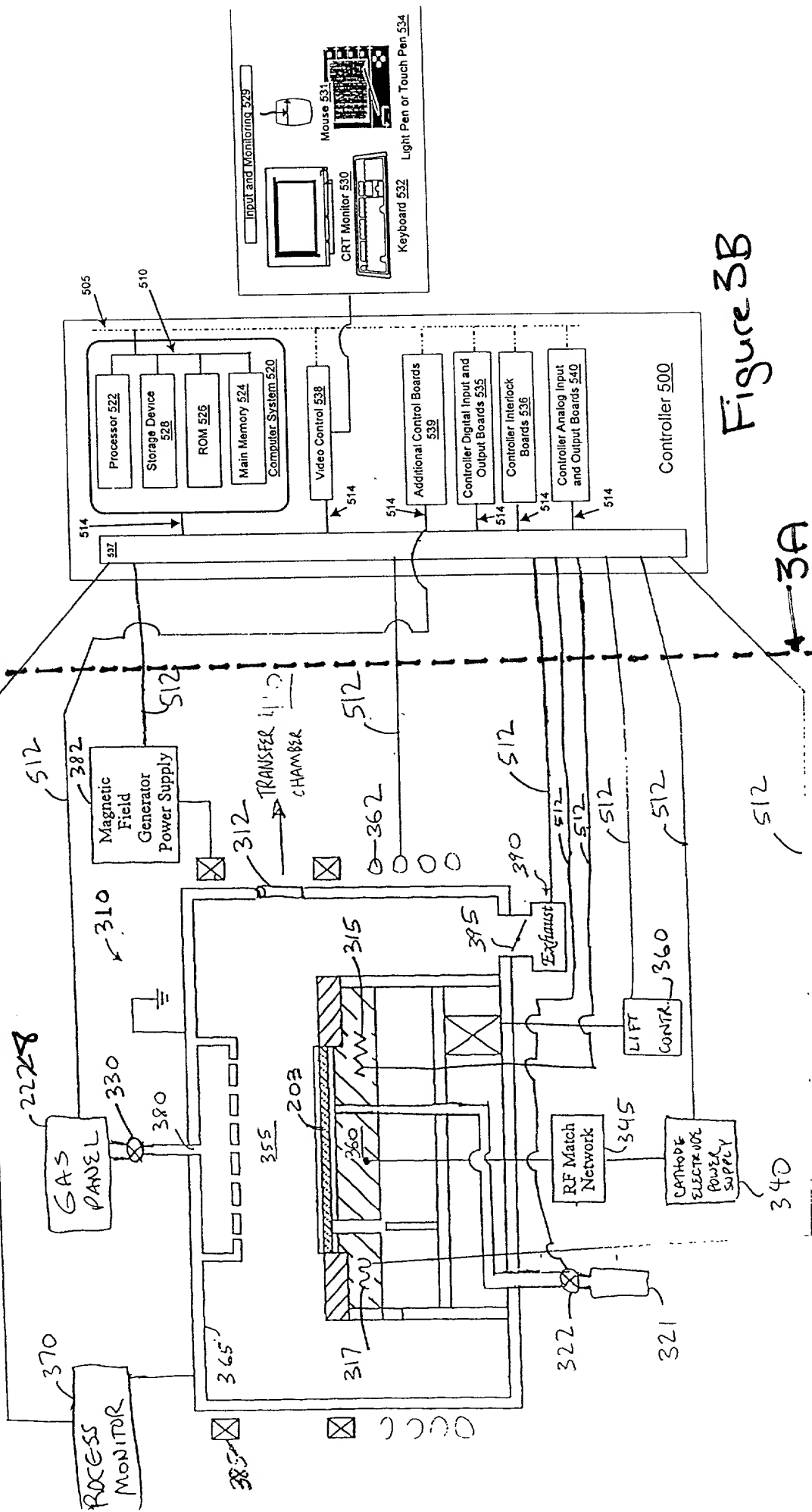


Figure 3B

Figure 5A

FIGURE 3